

PENOBSCOT RIVER AND BUCKSPORT HARBOR MAINE SURVEY

(REVIEW OF REPORTS)



U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

31 JULY 1963

25

R 11/63

SURVEY (REVIEW OF REPORTS)

PENOBSCOT RIVER AND BUCKSPORT HARBOR

MAINE

SYLLABUS

The Division Engineer finds that the existing Federal projects are adequate for present and prospective commerce. He finds that Federal provision of a deep-draft channel in the Penobscot River, Maine is not economically justified by the present and expected commercial vessel traffic. While benefits would result from the use of larger vessels the proportion of prospective users of deep-draft vessels has been found to be relatively small. Hence, the benefits are substantially less than the annual charges. He finds that the desired widening and deepening of the waterway in and near Bucksport Harbor and the Bangor-Brewer waterfront, does not warrant project modification. Therefore, the Division Engineer recommends no modification of the existing projects in the Penobscot River and in Bucksport Harbor at this time.

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 Trapelo Road
Waltham, Mass. 02154

NEDGW

31 July 1963

SUBJECT; Survey (Review of Reports) on Penobscot River
and Bucksport Harbor, Maine

TO: Chief of Engineers, ATTN: ENGOW-PD, Washington, D. C.

AUTHORITY

1. This report is submitted in compliance with resolutions adopted by the Committee on Public Works of the United States Senate on January 30, 1956 and on November 30, 1956, which read, respectively, as follows:

"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved 13 June 1902, be and is hereby requested to review the report of the Chief of Engineers on Penobscot River, Maine, published as House Document Numbered 652, Seventy First Congress, Third Session, and other reports with a view to determining whether any modification of the recommendations contained therein is advisable at this time, with particular reference to improvement of navigation conditions at and in the vicinity of Bucksport, Maine."

"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved 13 June 1902, be and is hereby requested to review the reports of the Chief of Engineers on Penobscot River, Maine, published as House Document Numbered 652, Seventy First Congress, Third Session, and other reports with a view to determining whether any modification of the existing project is advisable at the present time."

2. A review report was assigned to the New England Division by the Chief of Engineers *

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PURPOSE AND EXTENT OF STUDY

3. This study was made to determine the engineering feasibility and economic justification of modifying the existing Federal navigation project in the interest of commercial use of the Penobscot River. A public hearing was held in the City Hall at Brewer, Maine on 25 February 1958 to enable local interests to present their views and desires concerning navigation improvements. A detailed hydrographic survey consisting of soundings and probings was made of several sections of the waterway. These surveys supplemented reconnaissance and after-dredging surveys, already available, and were considered necessary for study of any navigation improvement. Available maps, commercial statistics, and other information, relative to the present and prospective use of the waterway, were obtained through field canvass, various publications, and by contact with Federal, State, and local officials and private interests.

DESCRIPTION OF NAVIGATION CONDITIONS

4. The Penobscot River drains an area of 8,570 square miles in Maine. It flows, generally, south for a distance of 200 miles from its northernmost branches near the Canadian border to its mouth at the head of Penobscot Bay, about 115 miles northeast of Portland. The two main branches of the river, the East and West Branches, meet at the Town of Medway, about 100 miles north of the mouth. Other tributaries are the Mattawamkeag River, the Piscataquis River, and Kenduskeag Stream. The river is tidal for 27 miles from its mouth to a dam at Bangor, which marks the head of navigation. This report considers the navigable portion of the river.

5. Approximately 20 miles south of Bangor at the Town of Bucksport, Verona Island separates the river into two channels. These channels rejoin again about 3 miles north of the mouth at Fort Point, Cape Jellison. The branch flowing along the east side of the island, called Eastern Channel, has a relatively narrow natural channel with depths ranging in general from 30 feet near the downstream junction to 16 feet at Bucksport. However, several shoal areas of 9 and 13 feet control depths in this branch, and restrict navigation of it primarily to recreational and other comparatively shallow draft vessels. The west branch contains the main ship channel with depths varying generally from 40 to 80 feet from Fort Point to Bucksport. The narrowest width of this river portion is located along the northwestern part of Verona Island and is about 1,000 feet wide, shore to shore. However, a shoal located on the west bank just north of Odom's Ledge, restricts the channel width to about 500 feet.

6. From Bucksport north to the Town of Winterport, a distance of approximately 5 miles, the width increases from 1,200 feet to somewhat more than a mile just below Winterport. This wide area is known as Frankfort Flats. This 5-mile section has a channel generally about 350 feet wide and 22 feet deep except for a narrow portion located at Lawrence Cove just above Bucksport. Lawrence Cove had a controlling depth of 23 feet after dredging in 1961, however, this area is subject to rapid shoaling as sawdust and sediment settles at this point.

7. Proceeding upstream from Winterport a winding ten-mile portion of the river extends north to the Town of Hampden. It gradually decreases in overall width from 1500 to about 800 feet. Depths for the navigable channel are generally between 25 and 35 feet, with widths ranging from 300 to 1000 feet.

8. The remaining 5 miles of navigable waterway from Hampden to the Cities of Bangor and Brewer has an average overall width of 800 feet and channel depths varying from 24 feet at Hampden to 14 feet at Bangor. A controlling depth of 13 feet is located just below the highway bridge. The Kenduskeag Stream, one of the larger tributaries, flows into the Penobscot River from the north-northeast at Bangor.

9. The mean range of tide varies from 10.3 feet at the mouth to 13.1 feet at the head of navigation. The mean ranges at various points are: Fort Point, 10.3 feet; Bucksport, 11.0 feet; Hampden, 12.8 feet, and Bangor, 13.1 feet. U. S. Coast and Geodetic Survey Chart No. 311 shows the river from Bangor south to, and including the major portion of Penobscot Bay. The river is also shown on Army Map Service Sheets: Castine - 7272 IV, Bucksport - 7273 III, Bangor - 7273 IV, and on the map accompanying this report.

TRIBUTARY AREA

10. The principal communities immediately tributary to that portion of the river under study in this report are listed below with their referenced locations and the 1950 and 1960 population figures.

Community	No. of Miles Above Fort Point	County	1950 Pop.	1960 Pop.
Town of Bucksport	7 - East bank	Hancock	3,120	3,466
Town of Winterport	13 - West bank	Waldo	1,694	2,088
Town of Orrington	20 - East bank	Penobscot	1,895	2,539
Town of Hampden	22 - West bank	Penobscot	3,608	4,583
City of Brewer	26 - East bank	Penobscot	6,862	9,009
City of Bangor	27 - West bank	Penobscot	31,558	38,912
Totals			48,737	60,597

The population totals for the immediate tributary communities, each of which increased during the period 1950 to 1960, represent a combined increase of over 24 percent. Hancock County encompasses a section east of the Penobscot River center line and south of South Orrington; Waldo County takes in an area west of the Penobscot River center line and south of South Orrington; Penobscot County encompasses both east and west tributary areas north of South Orrington. Nearly all of Penobscot County is served to some extent by waterborne commerce of the Penobscot River. The 1950 and 1960 population figures for this county were 108,198 and 126,346 respectively.

11. The Bangor-Brewer area is the third largest metropolitan area in Maine and constitutes the northern and eastern Maine center for transportation, commodity distribution, industry, banking, commerce, shopping, and service trade facilities. The junction of the Maine Central and Bangor and Aroostook Railroads is located at Bangor, this area, once the leading lumber shipping port of the world, has a diversity of manufacturers and numerous petroleum terminal facilities along both banks of the river. Some of the principal economic activities include food processing, paper and allied products, furniture, finished lumber, printing, and publishing. Several coal terminals are located on the west bank of the river just south of the Bangor-Brewer highway bridge.

12. The Town of Bucksport is a highway hub and site of a paper plant, the St. Regis Paper Company. It has an extensive business section. The towns of Hampden and Orrington are primarily farming and lumbering communities with limited commercial components. Winterport is a commercial and business center. All of these towns as well as Bangor-Brewer, derive income from the vacation-travel business. Recreational boating and commercial fishing also supplement the overall economy.

13. A network of roads serves the river area from Bucksport to Bangor. U. S. Route No. 1 traverses hilly terrain parallel to and along the west bank of the river, while State Route No. 15 runs along almost similar terrain on the east bank. Roads which converge at Bangor-Brewer are U. S. No. 1 from the south, State Routes 15 and 222 from the northwest, U. S. Route 2 and State Route 178 from the northeast, U. S. Route 1 from the east, and State Route 15 from the south. In addition, U. S. Alt. 1 and State routes 175 and 15 all enter Bucksport.

BRIDGES

14. Seven bridges span the river portion between its mouth at Fort Point and Bangor. Of these bridges, one is located on the Eastern channel, and one across the main channel at Bucksport; the remaining five are in the Bangor-Brewer area. The locations, ownership, and general physical description of these bridges are given in Table 1. Vessel traffic in Eastern Channel and in the waterway north to the downstream bridge at Bangor-Brewer is by relatively small craft. The bridge at Prospect has sufficient horizontal and vertical clearances for prospective traffic.

Miles Above Mouth (Fort Point 0-Miles)	Nearest Town	Owner	Type	No. of Spans	TABLE 1 Channel Spans Clear width normal to Channel (in feet)			Clear Height Above High Water	Clear Height Above Low Water	Use
					Left	Center	Right			
6.8	Prospect	Maine St. Hwy. Fixed Comm.	Fixed	3	---	750	---	135.00	146.00	Highway
*7.7	Bucksport	"	Fixed	16	---	65	---	17.00	28.00	Highway
26.4	Bangor Brewer	Maine St. Hwy. Comm.	Fixed	5	132	152	132	22.00	35.10	Highway
26.5	Bangor Kenduskeag Stream Bridge	Maine Central R.R.	Swing	4	40	---	40	6.25	19.35	Railroad
26.6	Bangor Kenduskeag Stream Bridge	Maine St. Hwy. Fixed Comm.	Fixed	3	32	30	30	8.07	21.17	Highway
26.8	Bangor Brewer	Cities of Bangor Brewer	Fixed	4	118	192	195	23.70	36.8	Highway
26.9	Bangor Brewer	Maine Central R.R.	Swing	8	39	---	39	20.00	33.1	Railroad

* Crosses Eastern Channel at Bucksport.

PRIOR REPORTS

15. The Penobscot River has been the subject of several reports dating back to 1866. The essential reports with accompanying descriptive data are listed below in Table 2.

TABLE 2

R & H Act Aug. 2, 1882	'Prel. Exam. 'Oct. 7, 1882 ' Survey 'Oct. 31, 1883 ' '	'Widening of channel at Bangor' '100' for distance of 4,500' 'to 14' depth (mlw); widen 'channel near Crosby Narrows 'to min. width of 250' and '12' depth (ext. lw)	'Sen. Ex. 'Fav. No. 44 '48th 'Cong. '1st Sess.	'Adopted 'July 5, '1884 ' ' '
R & H Act Aug. 5, 1886	'Prel. Exam. 'Jan. 11, 1887 ' Survey 'Jan. 11, 1888	'Channel 22' deep (mlw) by '400' wide between Winterport 'and Bucksport - about 6 miles '- construction of 5 jetties	'H. Ex. 'Fav. No. 133 '50th Cong. '1st Sess.	'Adopted 'Aug. 11, '1888 ' '
R & H Act Sept. 19, 1890	'Prel. Exam. 'Mar. 21, 1891 ' Survey 'Nov. 28, 1891 '	'Further widening of 60' at 'Bangor, construction of 2 'jetties at Crosby Narrows - '3 jetties between Winterport 'and Bucksport.	'H. Ex. 'Fav. No. 37 '52nd Cong. '1st Sess.	'Adopted 'July 13, '1892 ' '
R & H Act Sept. 5, 1896	' Survey 'Apr. 23, ' 1897 ' ' ' '	'Channel 90' wide by 2' deep '(ext. lw) in Kenduskeag R. 'from mouth to Kenduskeag 'Bridge - deepen Bangor Harbor 'in front of Boston & Bangor 'Steamboat wharf to 11' at 'extreme low tide.	'H 'Fav. No. 49 '55th Cong. '1st Sess.	'Adopted 'March 3, '1899 ' ' '
R & H Act Mar. 3, 1899	'Prel. Exam. 'Aug. 2, 1899 ' Survey 'Dec. 16, 1899	'Removing the "Middle Ground" 'at Bucksport Harbor to a 'depth of 16 feet.	'H 'Fav. No. 275 '56th Cong. '1st Sess.	'Adopted 'June 13, '1902 '
R & H Act Mar. 3, 1905	'Prel. Exam. 'June 5, 1905 ' Survey 'Apr. 4, 1906	'Further widening of the har- 'bor at Bangor.	'H 'Fav. No. 739 '59th Cong. '1st Sess.	'Adopted 'March 2, '1907 '
July 11, 1907	' ' ' '	'Declaring Kenduskeag Stream 'non-navigable ' '	' ' ' '	'Public 'Law '80th Cong. '1st Sec.

EXISTING CORPS OF ENGINEERS PROJECTS

16. In the area being considered in this report there are two Corps of Engineers' projects. One is located entirely within Bucksport harbor. It provides for deepening the "Middle Ground" in that harbor to 16 feet. The project was adopted in 1902 and completed in 1903. However, in 1938 the controlling depth over the area was only 6.1 feet. No maintenance dredging has been accomplished under this project.

17. The second project considers the entire navigable portion of the river, from the mouth to the Bangor-Brewer area. The project was adopted in 1884, and supplemented by enactments to 1947. It provides for a 22-foot deep channel, generally 350 feet wide, from Bucksport to Winterport, a distance of about 6 miles. It also provides for straightening, widening, and deepening to 15 feet, the channel near Crosbys Narrows and Stearns Mill. This portion of the river encompasses the area lying between 4.0 and 3.5 miles below Bangor. The project further provides for deepening the harbor at Bangor to 14 feet and widening it along the Bangor front, giving an additional channel width of 100 to 300 feet for a length of 2000 feet. The project was completed in 1913, at a cost of \$292,020 for new work. On 11 July 1947, Public Law 183, 80th Congress, 1st Session declared non-navigable the Kenduskeag Stream, a tributary of the Penobscot. This waterway had been improved under a prior project.

18. Maintenance dredging was last performed in 1961. This dredging was performed in the Frankfort Flats and Lawrence Cove area. Latest surveys indicate a controlling depth of 19 feet in the Bucksport - Winterport section of the river. Controlling depths in other areas are 15 feet to Stearns Mills, and 13 feet to the upper limit of the project. Annual maintenance for the Frankfort Flats - Lawrence Cove channel, is currently estimated at \$21,000.

LOCAL COOPERATION ON EXISTING AND PRIOR PROJECTS

19. There has been no monetary requirement of local cooperation on existing or prior projects. All improvements for the benefit of general navigation in the Penobscot River have been made by the Federal Government. No known improvements for general navigation have been accomplished by either local or state interests.

TERMINAL AND TRANSFER FACILITIES

20. The major concentrations of terminal facilities along the Penobscot River are located at Bucksport Harbor and in the Bangor-Brewer area. However, several intermediate facilities are active between these two areas, and one is located south of Bucksport. These facilities are described below beginning with the one downriver of Bucksport Harbor and proceeding upstream.

21. There is a fertilizer manufacturing plant, the Summers Fertilizer Co., located approximately 4 miles below Bucksport in the town of Stockton Springs. This terminal has a T-head type pier with a berthing depth of about 17 feet. The pier is equipped with an overhead conveyor system for transporting fertilizer materials from the vessel to the plant.

22. Terminal and transfer facilities at Bucksport Harbor include those of the St. Regis Paper Company, C. H. Sprague & Son Company, Webber Tanks, Inc., and the Central Maine Power Company. The easterly part of this harbor consists largely of burned out and broken piers and wharves. The St. Regis Paper Company has a 92' x 405' wood pile and timber pier, and a line of 8 dolphins (7 - 9' x 11' and 1 - 16' x 20') which is used for inclosing a pond area for holding logs as well as for docking purposes. The berthing depth is 24.5 feet. The paper company owns two tanks of 55,000 barrel capacity each for storage of residual oil for use in the paper mill. The C. H. Sprague & Son Co., with main offices in Boston, Massachusetts, has docking facilities adjacent to the paper company. The pier facility consists of a line of five cluster dolphins approximately 80 feet apart spanned by a walkway. In 1958 this company contracted for dredging a 150' x 700' berth 35 feet deep at their pier. They have an oil storage tank of 150,000 barrel capacity. Webber Tanks, Inc., jointly owned by the Dead River Company and the Webber Oil Company, has facilities at Bucksport for handling deep-draft tankers, barges, tank cars, and tank truck fuel deliveries. It has 5 fuel storage tanks with a total capacity of 476,000 barrels. Heating oils from their terminal are distributed to over 100 fuel oil distributors. The Central Maine Power Company has an oil storage tank at Bucksport of 90,000 barrel capacity.

23. The Northeast Coal & Dock Corporation of Bucksport owns and maintains a T-head type pier approximately 2 miles upstream from Bucksport Harbor. The pier is made up of 9 cluster pile dolphins with catwalks and walkways and has a total river frontage of 700 feet. The berthing depth is 24 feet. A discharge tower and conveyor system is available for unloading and transporting sulphur and coal brought to the dock in colliers, barges, and T-2 tankers. Two 10,000 ton liquid sulphur tanks and 10 acres of ground storage area for coal, are available.

24. A relatively new industrial enterprise, the Winterport Marina and Boatyard, Inc., is located on the west bank of the river, approximately 4 miles upstream of the Northeast Coal & Dock Corp.

This facility consists of five large Quonset-type buildings fronted by a 45-foot wide by 250-foot long wood pile and timber dock. There is a 14' x 36' dock slip and a twelve-ton capacity Travelift hoist for hauling and launching recreational craft. Fifty large cruisers can be stored in the Quonset huts while yard area is available for open storing of 80 boats.

25. Recently, the Bangor Scrap Iron and Metal Company of Odlin Road, Bangor, indicated plans to relocate at the site of the Stearns Mill area in Hampden. This company submitted a request in August 1962 for a Federal permit to allow for dredging a berthing area fronting on the old saw mill structure and for construction of a breasting dolphin. The proposed berth would involve dredging an area about 70' wide by 440' long to a depth of 18 feet. The company anticipates that about one vessel trip per year by a Liberty type ship would be required to transfer its stockpile of scrap metals out of the area.

26. The remaining terminal facilities of substantial size are located on the east and west banks of Bangor and Brewer along a 2 mile reach extending downstream from the main highway bridge. Industrial terminal facilities along the east bank include those of C. H. Sprague & Son Co. about 2 miles downstream of the highway bridge, Eastern Fine Paper Co., Tidewater Oil Co., Cities Service Oil Co., and Gulf Oil Corp. just below the bridge. Along the west bank are located the oil terminal facilities of Community Oil Co., Chevron Oil Co., Mobil Oil Co., American Oil Co., Sun Oil Co., Webber Oil Co., and Richfield Oil Co. Several coal companies are located along the Bangor waterfront immediately below the bridge. Extensive oil and coal handling and storage facilities are available at these terminals. Nearly all of the terminals along this reach have railroad connections. A small number of wharves and piers are located upstream of the highway bridge.

IMPROVEMENT DESIRED

27. A public hearing was held at Brewer, Maine on 25 February 1958 to determine the nature and extent of the improvements desired by local interests. The hearing was attended by State and City officials, business representatives, and other private interests. Approximately 30 people attended.

28. Captain William E. Abbott, a Penobscot Bay and River pilot, made the following requests on behalf of some of the tributary cities and towns and commercial interests.

a. Sound out the main channel from Odom's Ledge to Gondola Cove. The U. S. Coast Chart No. 311 indicates depths of 22 and 31 feet, but local interests believe greater depths exist there.

b. Deepen the bar lying between the northern tip of Verona Island and Bucksport Harbor for which the U. S. Coast Chart shows shoal spots of 6, 13, and 17-foot depths. This bar presents a difficulty to ships making the approach to Bucksport Harbor wharves.

c. Dredge the channel at Lawrence Cove to 25 feet.

d. Widen the south side of the channel immediately south of Frankfort Flats.

e. Widen the channel at Orrington opposite Hampden Highlands.

f. Dredge a 13-16 foot shoal at Crosbys Narrows to provide a 20-foot depth.

g. Provide a turning basin 15 feet deep in the vicinity of Stearns Mill for larger vessels using South Brewer facilities.

h. Deepen a 15-foot shoal lying off the Eastern Fine Paper Company terminal.

29. The Tidewater Oil Co. of Brewer requested (a) establishment of a 16-foot channel, (b) an anchorage in the Frankfort Flats area, (c) elimination of certain navigational hazards (requested above by the river pilot), and (d) normal maintenance.

30. Local interests of Bucksport expressed a desire for the removal of old burned out and broken piers and wharves located along the easterly section of the harbor.

31. Subsequent to the hearing the Board of Selectmen of the Town of Winterport, by letter dated 16 May 1962, requested that the survey study include exploring the feasibility of providing protection against ice flows which cause damage to the docking facilities of the Winterport Marina & Boatyard, Inc. Also, the C. H. Sprague & Son Co., and the Northeast Coal & Dock Corp. of Bucksport, in reply to

questionnaires sent in November 1961 to all tributary interests thought to be affected or concerned, requested that the river channel be deepened to allow for fully loaded T-2 type tankers and coal colliers.

32. The above desired improvements have been considered and are discussed later in this report.

EXISTING AND PROSPECTIVE COMMERCE

33. Total commerce on the Penobscot River below Bangor has increased from 625,000 tons in 1935 to 1,162,657 tons in 1961. Substantial decreases in waterborne commerce were experienced during the years of World War II and the Korean conflict. The longest sustained increase has been that from 1953 to 1961, with relatively minor fluctuations. Thus, the overall commerce trend from 1935 to 1961 has generally increased regularly in a straight line and at a substantial rate.

34. The waterborne commodity breakdown for 1961 (Waterborne Commerce Statistics - 1,162,657 tons) was as follows: 95% - petroleum and petroleum products; 3% - pulpwood and paper products; 1% - sulphur; 1% - coal and lignite; 1% - fertilizer, tar, veg, fish, etc. Relative to the petroleum and petroleum products commerce, 97% were receipts of which 30 percent were of foreign origin, 62% - coastwise, and 5% - intraport. The remaining 3% were domestic coastwise shipments. Of the pulpwood and paper products 26% were imports, 56% were coastwise receipts, and 18% were exports. All sulphur, coal and lignite were domestic receipts while all fertilizer, veg, etc. were exports. About 70% of the commerce in crude and coal tar were coastwise shipments. The type and amount of the waterborne commerce as stated above for 1961 are generally the same for previous years.

35. To aid in determining the specific areas along the river where commerce is received or shipped, the type and size of vessels used, and the amount of commerce involved, all available data were studied. This data, supplemented by field observation and local information, shows that practically all waterborne commerce is received at, or shipped from either the terminals along the 2-mile reach extending below the Bangor-Brewer highway bridge, or at and near Bucksport Harbor.

36. Petroleum and coal is transported upstream to Bangor and Brewer facilities chiefly by small motor vessels and barges. These

vessels vary in length from approximately 130' to 260' with loaded drafts of 11' to 14.5'. Capacities of petroleum carrying vessels range from 8,000 to 13,000 barrels. Similarly, relatively small vessels are used for transporting some of the other commodities, such as paper products, chemical, etc. However, the C. H. Sprague & Son Co. of Boston, with facilities at Searsport, Bucksport, and South Brewer, utilizes partially loaded T-2 type tankers of foreign flag for delivering an average of 860,000 barrels of residual oil annually to their S. Brewer terminal. The fuel is transferred via a 10 inch pipeline from the tanker to 3 storage tanks of 140,000 barrel total capacity, to be used as required by the nearby Eastern Fine Paper Co. The tankers are lightened to a draft of 21 feet by discharging part of the load either at Searsport or at Bucksport.

37. At Bucksport Harbor petroleum is brought in by both motor vessels and fully loaded ocean-going tankers, with the tendency toward use of the larger vessels. Total storage capacity at Bucksport is 850,000 barrels. The vessels used vary in length from 180' to 610' and in draft (loaded) from about 11' to 33'. The St. Regis Paper Co. ships an average of 40,000 tons of paper annually by barge and steamer, and receives an average of 15,000 tons of pulpwood in barges and converted L.C.T.s. It receives about 270,000 barrels of residual oil annually for use in the mill. This fuel is brought in by vessels ranging in length from 115' to 500' and in draft (loaded) from 6' to 28'.

38. The Northeast Coal & Dock Corporation of Bucksport receives about 65,000 tons of liquid sulphur and coal annually. T-2 tankers and barges with loaded drafts of 20' to 30' and lengths of 300' to 525' are used.

39. The Bangor Scrap Iron & Metal Co., presently relocating its operations to the Stearns Mill area at Hampden, indicates its intention to use a Liberty type cargo vessel to transport the annual scrap stockpile out of the area. A typical Liberty vessel is approximately 440 feet long with a loaded draft of 28 feet, and has dwt of 11,000 tons.

40. It is considered that total waterborne commerce on the Penobscot River will continue to increase. The increase will result from such factors as increased population of the area served, and its attendant demand for coal, petroleum products and other commodities.

41. The most substantial rate of increase in commerce occurred during the period 1953 to 1962. This rate is not anticipated to continue. It is considered that this above average increase resulted partly from the greater use of oil for heating purposes, particularly in domestic heating. At the present time such use is almost universal in the tributary area, as conversion from the use of other fuels is practically complete. Therefore, the increases in commerce from this source will result from normal population growth. However, some indication of industrial growth was tendered at the public hearing. While this industrial growth was not specifically indicated, it is considered that there is ample room for location of industry. However, this aspect of growth is not foreseeable at this time.

VESSEL TRAFFIC

42. The Penobscot River is used for navigational purposes by commercial vessels, fishing boats, and recreational craft. Table No. 3 below lists the totals of upbound and downbound trips and the drafts of commercial vessels navigating the river over the last 9 years, the most active period. The Table shows a tendency toward use of larger vessels. These deeper draft vessels discharge at Bucksport Harbor where sufficient channel and berth depths exist. The only large vessels using the upper river are partially loaded T-2 tankers drawing 21 feet. About 15 of these trips are made to the C. H. Sprague & Son Co. wharf at South Brewer. The major portion of those vessel trips, listed in the table as under 19' draft, are actually under 14' draft.

43. For 1961, which can be taken as generally representative of previous years, 965 of the total 1,073 upbound and downbound vessel trips were made by self propelled vessels and 108 by non-self propelled vessels. Included in the 965 trips above, were 777 by motor vessels and tankers, 246 by towboats or tugboats, and 44 by passenger and dry cargo ships. The non-self propelled vessel trips were made by 107 dry cargo barges and 1 tanker barge. No record of vessel trips by fishing and pleasure craft was obtained as navigation conditions are sufficient for these craft.

TABLE 3
VESSEL TRIPS

<u>Draft</u>	<u>1953</u>	<u>1954</u>	<u>1955</u>	<u>1956</u>	<u>1957</u>	<u>1958</u>	<u>1959</u>	<u>1960</u>	<u>1961</u>
Over 32'						1	8	8	7
30-32	14	13	13	14	15	13	15	19	25
27-29	2	3	7	7	10	8	9	3	4
24-26	4	19	9	21	11	11	9	12	4
21-23	19	21	43	37	41	37	46	43	50
19-20	8	21	20	21	22	12	22	10	7
Totals 19' and over	47	77	92	100	99	82	111	95	96
Percent of total	4.2	6.6	6.5	6.3	6.9	6.3	6.5	7.6	8.9
Totals under 19'	1,085	1,087	1,331	1,496	1,342	1,214	1,607	1,152	977
TOTALS	1,132	1,164	1,423	1,596	1,441	1,296	1,718	1,247	1,073

DIFFICULTIES ATTENDING NAVIGATION

44. Local information and field examination indicate that most of the navigation difficulties are due to channel constrictions and insufficient channel depths at various locations of the river. These problem points result from the formation of shoals caused by deposition of sedimentary materials and sawdust. The sawdust was carried downstream from saw mills north of Bangor. These trouble spots, as pointed out by the river pilot at the hearing, are located at Bucksport Harbor north of Verona Island, Lawrence Cove, Frankfort Flats, Hampden Highlands opposite Orrington, Crosbys Narrows at Hampden, and opposite the facilities of Eastern Fine Paper Co. of South Brewer.

45. Other navigation difficulties are encountered often during the winter months as a result of winter ice conditions, particularly upstream of Winterport. During extreme winters the river is closed to the mouth. An icebreaker generally has the river open for navigation by March. Freshets, which sometimes present a hazard to vessels, occur during March and April. Local interests claim that because of the strong ebb currents encountered during spring flood stages, vessels bound for Bangor, particularly large ones, find it advisable to anchor off Fort Point, Cape Jellison and start up the river about 3 hours after low water. Also, tidal delays are experienced by some of the deep draft vessels bound for the Northeast Coal & Dock Corp. of Bucksport and C. H. Sprague & Son Co. of S. Brewer.

46. Available statistics cite the grounding of a converted C-4 vessel 630 feet long and drawing 31 feet, about 15 feet off the dock at Bucksport Harbor. However, there is no record of any damages resulting from this grounding. There is no record of vessel damages from other groundings.

47. The above mentioned difficulties are experienced by the existing vessel traffic, which include partially-loaded T-2 tankers. Local interests claim that existing project depths preclude the use of these vessels fully loaded and also the more extensive use of them in future commerce.

WATER POWER AND OTHER SPECIAL SUBJECTS

48. This study does not involve any problems pertaining to water power, flood control, pollution, or related subjects. The project under review lies entirely within tidal waters.

DISCUSSION

49. The Penobscot River is an important commercial waterway of northeastern Maine. Its waterborne commerce in 1961 amounted to 1,162,657 tons. About 95% of this commerce were receipts of petroleum products. The remainder was comprised primarily of pulpwood and paper products, coal, and sulphur. Nearly all of this commerce was received at, or shipped from industrial terminals located at Bucksport and at the Bangor-Brewer area 20 miles upstream. Other active terminal facilities along the river include a fertilizer plant approximately 5 miles below Bucksport Harbor and a boatyard-marina at Winterport. A Bangor scrap metal company is acquiring a waterfront terminal at the site of the old Stearns Mill area in East Hampden, about 3 miles downstream of the Bangor-Brewer highway bridge. It plans to operate from this area.

50. At the public hearing held in 1958 and through replies to questionnaires made subsequent to the hearing, local interests made numerous and varied requests for improvement of the 27-mile navigable portion of the river from its mouth to Bangor. These requests have been considered and are discussed individually in the following paragraphs.

51. Two companies, the Northeast Coal & Dock Corp. of Bucksport and the C. H. Sprague & Son Co. of South Brewer, requested that the channel from Bucksport to Bangor be deepened to permit use of fully loaded T-2 tankers and coal colliers. As these were the only two companies which had initially indicated the need for deep draft channels, it was felt that other terminal operators might benefit from provision of a deepened waterway. To this effect questionnaires were forwarded to the 15 petroleum, coal, and paper companies upstream of the C. H. Sprague terminal in the Bangor-Brewer area. Of the 15 companies contacted, 9 replied. In summary the information received indicated that (a) some of the companies do not use the waterway as they are supplied by rail or truck; and (b) those which use the waterway indicated that present channel depths are adequate for their needs. Six companies did not reply indicating either superficial or no interest in the waterway. At Bucksport Harbor, the St. Regis Paper Company stated that its only direct concern with navigation is in the section from the harbor to the mouth. Present channel conditions are adequate for the type and size of vessels they use. The owners and operators of the oil terminal facilities at Bucksport Harbor currently receive petroleum in deep-draft T-2 type tankers and have not indicated that navigation

improvements are desired. Therefore, benefits based upon the use of larger vessels by the two companies mentioned above, have been estimated for 35, 30, and 25-foot deep channels from Bucksport to a point opposite Eastern Fine Paper Co. of South Brewer. It has been found that while reasonably substantial benefits could be expected to accrue to these two individual oil and coal enterprises, and hence the general public, the cost of providing the necessary channel depths far outweigh these benefits. Benefits to be realized would result from elimination or reduction of tidal delays, reduced transportation costs through the use of larger and fully loaded vessels, and reduction of tug services. A more detailed breakdown of the estimates of benefits and costs is given in Appendix "A".

52. At the public hearing, Tidewater Oil Co. of Brewer requested a 16-foot channel at Bangor and an anchorage near Frankfort Flats. This was not found economically justifiable. Aside from the previously described commerce to the C. H. Sprague terminal in South Brewer, commerce to terminals in the Bangor-Brewer area is delivered in towed and self propelled barges. These vessels have loaded drafts ranging from 8 to 14 feet, with the major portion in the 11- to 13-foot class. It is estimated that prospective commerce would consist mainly of similar type vessels, with a possibility of future use of larger vessels drawing about 16 feet. The extent of the use of such larger vessels cannot be determined at this time, as no indication was made by local interests as to probable future use of them. In any case, the vessels could navigate the existing 14-foot channel with minor tidal delays. Deepening of the river to eliminate these tidal delays is not considered economically justifiable.

53. In addition, it is also considered that the requested anchorage is unnecessary. The only function of additional anchorage would be to provide space for vessels waiting for docking space. Additional terminal facilities could meet this need.

54. In addition to the previously described requests for improvement, one of the local river pilots requested several specific items of channel widening and deepening in various locations. These items are listed in the section, "Improvement Desired." The specific items are discussed briefly in the following paragraphs.

55. At the mouth of the river, between Odom's Ledge and Gondola Cove, the natural deep channel narrows to a least width of about 500 feet between the 30-foot depth lines. U. S. Coast & Geodetic Survey data indicates depths of 60 feet for a width of 200 feet.

Since the indicated depths and widths were considered adequate for the existing and foreseeable commerce and no improvement would be necessary in the area, no field surveys were made.

56. At Bucksport Harbor, at the head of the Eastern channel, between Verona Island and the Mainland, a natural bar, locally known as the "Middle Ground", builds up periodically. Removal of this bar was requested. Since the deepening of the bar to 16 feet is part of the existing project it was considered that this item of improvement could be accomplished under ordinary maintenance if found justifiable. It was considered also that existing and prospective commerce in this part of the waterway did not warrant any modification to provide for deepening beyond the authorized depth

57. In the portion of the river about a mile above Bucksport and opposite Lawrence Cove, a 25-foot channel was requested. The existing project provides for a 22-foot channel in this area. It was claimed that this portion of the river as well as portions of the channel above, in the vicinity of Frankfort Flats, fills in rapidly after completion of each periodic maintenance. The 25-foot depth was requested for the purpose of using larger vessels in future commerce. Of itself it is not considered that sufficient benefits are available to warrant increasing project depths for the anticipated vessel traffic. The rapid shoaling results from the natural tendency of the river flows to create the cross sectional areas necessary to maintain a constant discharge. The sections of scour and deposition attendant to a river discharge, can be disciplined somewhat by man made control structures such as hurdles, spurs, jetty fields, etc., and have been used successfully in rivers upstream of tidal areas. Knowledge of the results of such structures in a tidal estuary is somewhat limited at this time. It is felt that their use could be considered under a future maintenance program for the Penobscot River trouble spots. Dredging the channel at these areas to 25 feet would not be an effective permanent measure against shoaling, but rather an advance maintenance action to increase the time intervals between periods of maintenance of the existing 22-foot project.

58. Widening of the existing 350-foot channel in the reach of river immediately south of Frankfort Flats was also requested. However, it was considered that difficult navigation in this area resulted from a combination of tidal flow and the absence of navigation aids on the bank south of the channel. Since the time of the hearing the south bank has been marked by two black buoys. River

pilots had indicated at the hearing that such marking would ease navigation hazards in this reach of the waterway.

59. The remaining items requested would involve widening and deepening the channel at three locations, namely, Orrington, Grosbys Narrows, and Stearns Mills and provision of a turning basin for larger vessels in the area opposite the Eastern Fine Paper Company at South Brewer. Hydrographic surveys were made in these areas in 1961. The surveys indicate that with the exception of the channel off Eastern Fine Paper Co., the widths between the contours of project depth, i.e., 14' at Bangor and 15' below Bangor, vary from 350 to 400 feet. These widths are considered sufficient for the number and size of vessels now using and expected to use the waterway. A shoal on the west side of the river at Eastern Fine Paper Co. restricts the channel width to 150 feet. Widening of this area as well as the other areas above would have to be considered under periodic maintenance, since they are essentially within existing project limits and their accomplishment would not constitute a project modification. Deepening of these areas has been discussed in paragraph No. 53.

60. The improvements requested by local interests at Bucksport for removing the old burned out piers and wharves along the harbor waterfront are considered to be outside the limits of Federal jurisdiction.

61. On behalf of the Winterport Marina and Boatyard, the Selectmen of Winterport requested protection from ice floes, which sometimes cause considerable damage to the marina facilities. A barrier structure would be required just above the facility to contain or deflect the ice. Such a structure is not considered to be a Federal responsibility.

62. Some benefits to future commerce would accrue from improvement of the waterway. The benefits have been derived for provision of a 25, 30 or 35-foot deep channel from Bucksport to South Brewer, and based upon savings expected to accrue to two terminal facilities, - i.e., one at Bucksport and the other approximately 17 miles upstream at South Brewer. The benefits are insufficient to justify project construction. Insufficient justification is further substantiated by the fact that all but the one terminal owner on the upper river either evinced no interest in improvement or indicated they were satisfied with present conditions. Local interests had stated at and subsequent to the public hearing held in February 1958 that several large shipping firms had indicated an interest in locating in the Bangor-Hampden area. To date no new industries capable of generating deep-draft vessel traffic have located

in this area. While it is recognized that population increases in the tributary area, availability of developable shorefront property, and the accessibility of an extensive industrial complex indicate good potential for attracting new industry, no concrete information is available which can be used to forecast additional deep-draft waterborne commerce with reliability as to type, location, and volume. A future review of the project would be advisable at any time that reliable estimates could be made of added use of the river potential.

CONCLUSIONS

63. The Division Engineer concludes that benefits resulting from provision of a deep-draft channel in the Penobscot River, Maine would be insufficient to economically justify the annual costs that would result from its construction and annual maintenance.

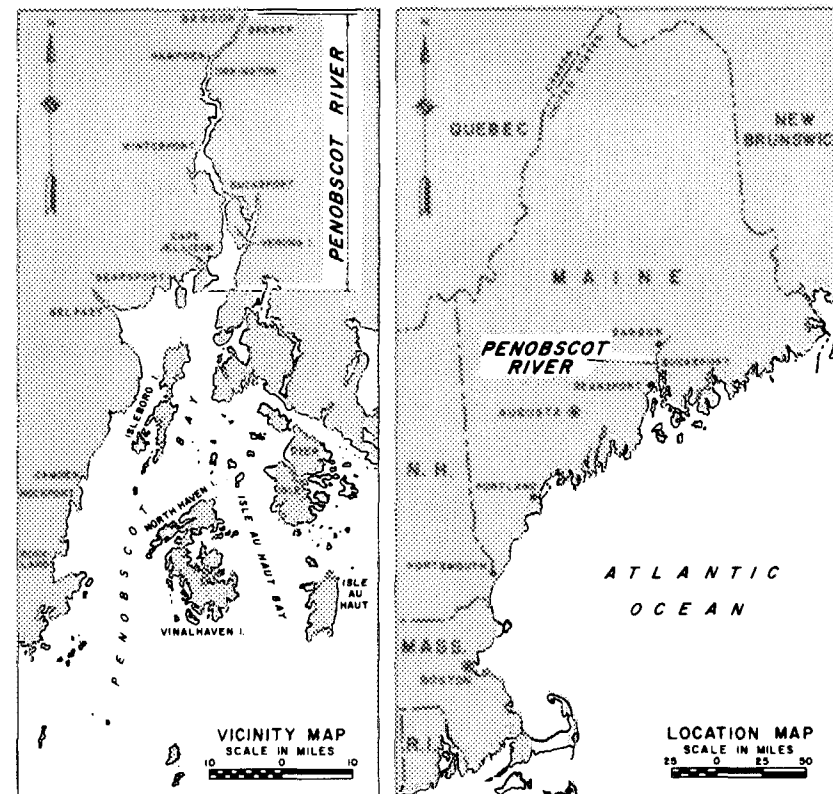
RECOMMENDATION

64. In view of the foregoing, the Division Engineer recommends no modification of the existing project in the Penobscot River or at and in the vicinity of Bucksport Harbor, at this time.

P. C. HYZER
Brigadier General, USA
Division Engineer

ANCHORAGE:
16 FEET DEEP AT BUCKSPORT HARBOR

CHANNEL:
22 FEET DEEP TO WINTERPORT
15 FEET DEEP TO BREWER
14 FEET DEEP ALONG BANGOR WATERFRONT



CHANNEL:
25, 30, & 35' x 350' TO SOUTH BREWER
16' x 300' TO BANGOR

U S ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS, WALTHAM, MASS.			
PENOBSCOT RIVER AND BUCKSPORT HARBOR, MAINE			
SHEET 1 OF 1	SCALE IN FEET		JULY 1963
5000	0	5000	10,000
APPROVED: <i>Wm. F. Baker</i>		TO ACCOMPANY SURVEY REPORT DATED JULY 31, 1963	
CHIEF ENGINEERING DIVISION			
SUBMITTED: <i>J. H. Lee</i>			
CHIEF PLANNING AND RECONSTRUCTION BRANCH			
CHIEF SURVEYING BRANCH			
CHIEF RIVER AND HARBOR SECTION		TRUE (ALD)	FILE NO. 1593 D-12-2
CHIEF OF DISTRICT		TRUE (ALD)	
CHIEF OF DISTRICT		TRUE (ALD)	

PENOBSCOT RIVER AND BUCKSPORT HARBOR, MAINE

APPENDIX A

ESTIMATES OF FIRST COSTS AND ANNUAL CHARGES

1. General. - This appendix includes estimates of first costs and annual charges for providing a channel from Bucksport to South Brewer. Depths of 25, 30, and 35 feet were considered. While no estimate was made of non-Federal costs, it is pointed out that in the event channel deepening had been found to be justified, affected local interests would have been expected to provide berthing depths commensurate with the channel depth.

2. Cost Estimates. - Details of first costs in this appendix include estimates of dredging costs, contingencies, engineering and design, supervision and administration. Preauthorization study costs were not included in computing annual charges. Estimates of Federal annual charges include an interest rate of 3 percent, amortization for both a 50-year and a 100-year project life, and estimates of additional annual maintenance.

3. Materials. - The materials were assumed to be ordinary materials consisting of mud, sand, and gravel.

4. Unit Price. - Unit prices are based on recent experience in similar dredging in the locality. The character and amount of the materials are such that it was considered the work would be accomplished by bucket dredge with spoil materials carried downstream by scow to dumping grounds in Penobscot Bay.

5. Maintenance. - The estimated additional annual maintenance quantities are based on shoaling experienced in the existing channel with adjustments to allow for a deeper and wider channel.

6. Overdepth and Side Slopes. - Estimated dredging quantities allowed for 2 feet overdepth, and side slopes of 1 vertical on 3 horizontal.

PROJECT COST ESTIMATES

Cost
Account
Number

Estimated First Costs:

<u>Item</u>	<u>35' Channel</u>	<u>30' Channel</u>	<u>25' Channel</u>
09 CHANNELS			
Dredging (Ordinary materials)	12,000,000 c.y. @ \$1.15 \$13,800,000	7,000,000 c.y. @ \$1.25 \$8,800,000	3,500,000 c.y. @ \$1.35 \$4,700,000
Contingencies @ 15%	\$ 2,100,000	\$1,300,000	\$ 700,000
30 ENGINEERING AND DESIGN	560,000	350,000	200,000
31 SUPERVISION AND ADMINISTRATION	<u>940,000</u>	<u>600,000</u>	<u>340,000</u>
* TOTAL FEDERAL CONSTRUCTION COSTS	\$17,300,000	\$11,050,000	\$5,940,000

* Does not include pre-auth. studies.

Federal Investment

First Cost	\$17,300,000	\$11,050,000	\$5,940,000
Interest During Constr. 3 yrs.	700,000		
TOTAL	<u>\$18,000,000</u>	<u>\$11,050,000</u>	<u>\$5,940,000</u>
Say	\$18,000,000	\$11,000,000	\$6,000,000

Federal Annual Charges - - - 50-year life

	<u>35' Channel</u>	<u>30' Channel</u>	<u>25' Channel</u>
Interest on Investment @ 3%	\$540,000	\$330,000	\$180,000
Amortization @ 0.887%	<u>\$160,000</u>	<u>\$ 98,000</u>	<u>\$ 53,000</u>
	\$700,000	\$428,000	\$233,000

Federal Annual Charges (Cont'd)

	<u>35'</u> <u>Channel</u>	<u>30'</u> <u>Channel</u>	<u>25'</u> <u>Channel</u>
Additional Channel) Maintenance) and) Annual Maintenance) Navigation Aids)	\$ 30,000	\$ 25,000	\$ 15,000
TOTAL CHARGES	\$730,000	\$453,000	\$248,000
Say	\$730,000	\$450,000	\$250,000

Federal Annual Charges - - - 100-year life

Interest on Investment @ 3%	\$540,000	\$330,000	\$180,000
Amortization @ 0.165%	<u>30,000</u>	<u>18,000</u>	<u>10,000</u>
	570,000	348,000	190,000
Annual Channel) Maintenance) and) Annual Maintenance) Navigation Aids)	\$ 30,000	\$ 25,000	\$ 15,000
TOTAL CHARGES	\$600,000	\$373,000	\$205,000
Say	\$600,000	\$370,000	\$205,000

TOTAL FEDERAL AND
NON-FEDERAL ANNUAL CHARGES

50-year life	\$730,000	\$450,000	\$250,000
100-year life	\$600,000	\$370,000	\$205,000

APPENDIX B

ECONOMICS

1. The benefits discussed in the appendix have been estimated entirely from savings expected to accrue to two terminals, - the C. H. Sprague and Son Co. of Searsport, Bucksport and South Brewer, and the Northeast Coal and Dock Corp. of Bucksport.

2. The C. H. Sprague & Son Co. - This company currently receives about 15 fully loaded T-2-type oil tankers of foreign flag annually at their facilities in the Penobscot Bay and River area. Present practice involves discharging part of the oil at Searsport or Bucksport to lighten the vessel to a draft of about 21 feet, thus permitting passage of the vessel upstream to South Brewer. The controlling depth is taken as 19 feet at Lawrence Cove, an area which is subject to very rapid shoaling. Since 1957 an average of 127,000 long tons of residual fuel have been received at the Sprague facilities in South Brewer. Based upon 15 trips by partly loaded tankers, this represents about 8,500 tons per trip. Thus it is seen that the vessels are lightened from the full net cargo capacity of 16,200 long tons (30' draft) to 8,500 long tons (20' draft). Allowing for an additional 5-foot keel clearance for uneven loading, squat, pitch, and maneuverability, a vessel light loaded to 20 feet requires 25 feet of water depth; hence it must wait for 6 feet of tide in a channel with controlling depth of 19 feet. The mean tide range at Bucksport is 11 feet. From the typical tidal curve for 11 feet the time the tide is lower than the 6 feet required is 6.56 hours, which represents $(6.56/12.4 \times 6.56/2)$ or 1.7 hours average tidal delay per trip. In addition, this method of operating involves an extra \$1,400 in tugboat charges for the intermediate port stop for lightening the ship. The cost of bringing the vessel to South Brewer from the intermediate river and bay ports is estimated to be approximately \$5,000. This cost is based upon an average of one day for the upbound and downbound trip at \$111/hour and one day in port at \$94/hour. The cost per ton for the present method of oil delivery to South Brewer is \$5,000 divided by 8,500 L.T. or \$0.59/ton.

3. In the event a 25-foot deep channel were provided to South Brewer, it is estimated that partial loads of about 11,400 long tons could be delivered to South Brewer, requiring only 11 trips per year instead of the present 15 trips. Tug service required for the intermediate port stops would be reduced by $\$1,400 \times 4$ trips, or about \$6,000. Light loading to 11,400 tons represents a draft of about 24 feet. Channel depth required would be $24 + 5$ or 29 feet. The four feet of tide required would involve an average tidal delay per trip of 1.1 hours. Therefore, savings would result from

a reduction in tidal delays of (1.7 hours/trip x \$111/hour x 15 trips/year) - (1.1 hours/trip x \$111/hour x 11 trips/year), or about \$2,000. The cost per ton for delivery from the intermediate port stops to South Brewer would be approximately \$5,000 divided by 11,400 tons or \$0.44 per ton. Therefore, savings in delivery costs would amount to \$0.59 - \$0.44 or \$0.15/ton. Resulting annual benefits would be \$0.15 x 127,000 tons or \$19,000.

4. Prospective commerce was based upon an indication by C. H. Sprague and Son Co. that they anticipate receipts of 1,250,000 barrels of residual oil by 1975 at their South Brewer terminal. This represents a rate of increase of about 28,000 barrels/year and it is considered this rate would be maintained on a straight line basis for the next 50 years. Thus, the total receipts at the end of year 2012 would be 2,260,000 or 334,000 long tons, an additional prospective increase of 334,000 - 127,000 or 207,000 long tons. Therefore, based upon current methods of delivery and the present channel depths the number of trips involved in the additional prospective commerce would be 207,000 divided by 8,500, or about 25 trips. If a 25-foot channel were provided, the prospective commerce could be delivered by 207,000 divided by 11,400, or 18 trips. Tug service at intermediate port stops would be reduced by \$1,400 x (25-18) trips, or \$10,000. The equivalent annual savings for the 50-year period would be $0.396 \times \$10,000$ or \$4,000. Tidal delays would be reduced by (1.7 hours/trip x \$111/hour x 25 trips/year) - (1.1 hours/trip x \$111/hour x 18 trips/year) or about \$2,500. The equivalent annual savings for the 50-year period would be $0.396 \times \$2,500$, or about \$1,000. Savings in delivery costs would amount to \$0.15/ton x 207,000 tons or \$31,000. Equivalent annual savings would be $0.396 \times \$31,000$, or \$12,000. The above computed benefits for providing the 25-foot deep channel are summarized in Table II.

5. In the event a 30 or 35-foot deep channel were provided to South Brewer, C. H. Sprague and Sons Co. could deliver the residual fuel in fully loaded T-2 tankers carrying 16,200 long tons per trip. The number of trips which would be eliminated would be (15-8) or 7 for present commerce and (25-13) or 12 for additional prospective commerce. The delivery costs would be reduced by \$0.59/ton - (\$5,000/16,200 tons) or \$0.59 - \$0.31 = \$0.28/ton. Tidal delays would be reduced if the 30-foot channel were provided, and eliminated entirely if the 35-foot channel were provided. The estimates of benefits for providing the 30 and 35-foot channels have been computed in the same manner as for the 25-foot channel mentioned above and are summarized in Tables III and IV.

6. The Northeast Coal and Dock Corp. - This company receives coal and liquid sulphur at its terminal in Bucksport. The Freeport Sulphur Company of New York has stated that they deliver 75,000 long tons of liquid sulphur to the Northeast Coal and Dock Corporation annually by means of a converted T-2 tanker. This constitutes a relatively recent method of delivery. Previous published figures

in Waterborne Commerce Statistics indicate delivery of dry sulphur. Available data indicates average receipts of about 15,000 tons of coal per year.

7. Information obtained from questionnaires submitted to the Northeast Coal and Dock Corporation indicates about 6 vessel trips per year by T-2 tanker carrying liquid sulphur from Gulf ports. This represents an average delivery per trip at the Bucksport terminal of 12,500 tons. Based upon an average net cargo of 16,200 long tons for a fully loaded T-2 tanker, it is estimated that the vessel is lightened at some nearby intermediate port by 16,200 - 12,500 or about 3,700 tons. Based upon 800 long tons per foot of draft, the vessel is lightened from 30 feet to about 25 feet. With an allowance of an additional 5 feet of hull clearance for uneven loading, squat, pitch, and maneuverability, the depth of channel required is $25 + 5$, or 30 feet. Since the controlling depth is taken as 19 feet at the Lawrence Cove area and the tide is 11 feet, the vessel must enter the shoal area at high tide. The average tidal delay involved is 6.2 hours. This is substantiated by information submitted by the Northeast Coal and Dock Corp. In addition, it is estimated that the intermediate stop at a nearby port en route involves an extra 8 hours of time for the inbound and outbound trip and 8 hours in port for lightening the vessel. This added expense amounts to $(\$178/\text{hour} \times 8) + (\$161/\text{hour} \times 8)$, or about \$2,700 per trip. The vessels used are of U. S. Flag. Also, it is estimated that an added cost of \$2,500 per trip is incurred for tug service at the intermediate port stop.

8. In the event a 25-foot channel were provided a fully loaded tanker carrying an average net cargo of 16,200 long tons could be utilized but only at near high tide. The channel depth at high tide would be $25 + 11$ or 36 feet. The channel depth required would be $30 + 5$ or 35 feet. The reduction in tidal delays over the present method of partial loading would result from the 1-foot tide differential and the elimination of one trip (75,000 divided by 16,200 = 5 trips). Since the annual delivery of 75,000 tons could be made directly to the terminal without intermediate port stops, tug service in the amount of $\$2,500 \times 6$ trips would be eliminated as well as extra time in the amount of $\$2,700 \times 6$ trips, or a total savings of about \$31,000. These benefits are summarized in Table V.

9. In the event a 30 or 35-foot channel were provided, the same method of delivery would be utilized as for the 25-foot channel described in paragraph 8, but with greater reduction in tidal delays. The benefits for the 30 and 35-foot channels are summarized in Tables VI and VII.

10. Based upon available statistics, prospective commerce in liquid sulphur is expected to total 2.5 times current receipts by the year 2012, or 187,000 tons. This is an added prospective

increase of 187,000 - 75,000 or 112,000 tons. This would involve about 9 trips. The benefits for this commerce have been computed in a manner similar to that for present commerce and are summarized in Tables V, VI, and VII.

11. Current receipts of coal at Northeast Coal and Dock Corp. are about 15,000 short tons/year. The present method of delivery is by self-propelled barge of the C1-M type. If the channel were deepened Company officials indicate that 11,000 dwt. colliers would be used for coal deliveries. A comparison of the delivery costs for both types of vessels from the port of origin at Norfolk, Virginia to Bucksport, Maine is given on page B-15. Savings in the amount of \$2.42 - \$1.35 or \$1.07/ton could be saved through use of the larger vessel. The draft of a fully loaded C1-M vessel is about 21 feet. Allowing for 3 feet of hull clearance, the vessel requires 24 feet of channel depth. Therefore, 5 feet of tide is necessary before the vessel can navigate over the 19-foot shoal. The average tidal delay is 1.4 feet per trip.

12. In the event a 25-foot channel were provided, fully loaded 11,000 dwt colliers could be utilized. The depth of channel available would be $25 + 11$ or 36 feet at high tide. The depth of channel required would be $28.5 + 4.5$ (hull clearance) or about 33 feet. Therefore, 8 feet of tide would be required. The increased tidal delays would be more than offset by the fewer number of annual trips required and the much greater savings in delivery costs to be realized. The benefits are summarized in Table VIII.

13. In the event a 30 or 35-foot channel were provided, savings of \$1.07/ton would be realized through use of the larger vessel as in the case of the 25-foot channel. The attendant tidal delays would not be reduced substantially. The tide required for the 30-foot channel would be 2 feet involving an average delay of 0.8 hours; for the 35-foot channel no delays but savings would be negligible. See Tables IX and X.

14. Prospective coal commerce to the Northeast Coal and Dock Corporation is based upon projected increases at nearby similar type harbors recently considered for improvement for navigation. The increases indicated were 2 percent per year for the next 50 years before leveling off. This represents $0.02 \times 15,000$ or 300 tons/year for Bucksport. By the year 2012 total receipts would be 15,000 (current) plus 300×50 or 15,000 (additional prospective) - 30,000 tons. This is considered reasonable in view of the anticipated change in types of energy fuels. Benefits for prospective coal commerce are summarized in Tables VIII, IX and X.

15. The interest rate used was 3 percent and the growth factors for the 50-year life and 100-year life are 0.396 and 0.514, respectively. Benefits for the 100-year life were computed in a manner similar to the 50-year life and are summarized in Table I.

TABLE I. SUMMARY OF BENEFITS

50-Year Life

	<u>35'</u> <u>Channel</u>	<u>30'</u> <u>Channel</u>	<u>25'</u> <u>Channel</u>
C. H. Sprague & Son Co. (Eliminated or reduced tug service, tidal delays, and delivery costs)	\$ 81,000	\$ 79,000	\$ 44,000
Northeast Coal & Dock Corp. (Eliminated or reduced tidal delays and delivery costs)	<u>82,000</u>	<u>79,000</u>	<u>76,000</u>
TOTALS	\$ 163,000	\$ 158,000	\$ 120,000

100-Year Life

C. H. Sprague & Son Co.	90,000	88,000	49,000
Northeast Coal & Dock Corp.	<u>90,000</u>	<u>87,000</u>	<u>84,000</u>
TOTALS	\$ 180,000	\$ 175,000	\$ 133,000

BENEFIT-COST RATIOS

50-year life	$\frac{163,000}{730,000} = 0.22$	$\frac{158,000}{450,000} = 0.35$	$\frac{120,000}{250,000} = 0.48$
100-year life	$\frac{180,000}{600,000} = 0.30$	$\frac{175,000}{370,000} = 0.47$	$\frac{133,000}{205,000} = 0.65$

TABLE II - ESTIMATE OF BENEFITS

<u>25-Foot Channel</u>		<u>50-year life (growth factor 0.396)</u>
<u>Source & Type of Benefit</u>	<u>Derivation</u>	<u>Total</u>
C. H. Sprague & Son Co. Eliminated or reduced tug service	Present	
	\$1,400/rd. trip x (15 - 11) trips eliminated	\$ 6,000
	Additional Prospective	
	\$1,400/trip x (25 - 18) trips eliminated = \$10,000 Equiv. annual savings = \$10,000 x 0.396 =	\$ 4,000
Reduced tidal delays	Present	
	(1.7 hrs/trip x \$111/hr. x 15 trips/yr.) - (-1.1 hrs/trip x \$111/hr. x 11 trips/yr.) =	\$ 2,000
	Additional Prospective	
	(1.7 hrs/trip x \$111/hr x 25 trips/yr.) - (-1.1 hrs/trip x \$111/hr x 18 trips/yr.) = \$2,500 Equiv. annual savings = \$2,500 x 0.396 =	\$ 1,000
(1) Reduced delivery costs	Present	
	\$0.15/ton savings x 127,000 tons/yr. =	\$19,000
	Additional Prospective	
	\$0.15/ton savings x 207,000 tons/yr. = \$31,000 Equiv. annual savings = \$31,000 x 0.396 =	\$12,000
Total		\$44,000

(1) Savings/ton based on cost of \$5,000 for delivery from Bucksport to Brewer
(One day upbound and downbound @ \$111/hr. and one day in port @ \$94/hr.)
divided by tonnage carried. Delivery by vessels of foreign flag.

TABLE III - ESTIMATE OF BENEFITS

<u>30-Foot Channel</u>		<u>50-year life (growth factor 0.396)</u>
<u>Source & Type of Benefit</u>	<u>Derivation</u>	<u>Total</u>
C. H. Sprague & Son Co. Eliminated or reduced tug service	Present	
	\$1,400/rd. trip x (15 - 8) trips eliminated	\$10,000
	Additional Prospective	
	\$1,400/trip x (25 - 13) trips eliminated = \$17,000 Equiv. annual savings = \$17,000 x 0.396 =	\$ 7,000
Reduced tidal delays	Present	
	(1.7 hrs/trip x \$111/hr. x 15 trips/yr.) - (1.4 hrs/trip x \$111/hr. x 8 trips/yr.) =	\$ 2,000
	Additional Prospective	
	(1.7 hrs/trip x \$111/hr x 25 trips/yr.) - (1.4 hrs/trip x \$111/hr x 13 trips/yr.) = \$2,700 Equiv. annual savings = \$2,700 x 0.396 =	\$ 1,000
(1) Reduced delivery costs	Present	
	\$0.28/ton savings x 127,000 tons/yr. =	\$36,000
	Additional Prospective	
	\$0.28/ton savings x 207,000 tons/yr. = \$58,000 Equiv. annual savings = \$58,000 x 0.396 =	<u>\$23,000</u>
Total		<u>\$79,000</u>
(1) Savings/ton based on cost of \$5,000 for delivery from Bucksport to Brewer (One day upbound and downbound @ \$111/hr. and one day in port @ \$94/hr.) divided by tonnage carried. Delivered by vessels of foreign flag.		

TABLE IV - ESTIMATE OF BENEFITS

<u>35-Foot Channel</u>		<u>50-year life (growth factor 0.396)</u>
<u>Source & Type of Benefit</u>	<u>Derivation</u>	<u>Total</u>
C. H. Sprague & Son Co. Eliminated or reduced tug service	Present	
	\$1,400/rd. trip x (15 - 8) trips eliminated	\$10,000
	Additional Prospective	
	\$1,400/trip x (25 - 13) trips eliminated = \$17,000 Equiv. annual savings = \$17,000 x 0.396 =	\$ 7,000
Eliminated tidal delays	Present	
	(1.7 hrs/trip x \$111/hr. x 15 trips/yr.) - 0	\$ 3,000
	Additional Prospective	
	(1.7 hrs/trip x \$111/hr. x 25 trips/yr.) - 0 = \$4,700 Equiv. annual savings = \$4,700 x 0.396 =	\$ 2,000
(1) Reduced delivery costs	Present	
	\$0.28/ton savings x 127,000 tons/yr. =	\$36,000
	Additional Prospective	
	\$0.28/ton savings x 207,000 tons/yr. = \$58,000 Equiv. annual savings = \$58,000 x 0.396 =	<u>\$23,000</u>
Total		<u>\$81,000</u>

(1) Savings/ton based on cost of \$5,000 for delivery from Bucksport to Brewer
(One day upbound and downbound @ \$111/hr. and one day in port @ \$94/hr.)
divided by tonnage carried. Delivered by vessels of foreign flag.

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TABLE V - ESTIMATE OF BENEFITS

<u>25-Foot Channel</u>		<u>50-year life (growth factor 0.396)</u>
<u>Source & Type of Benefit</u>	<u>Derivation</u>	<u>Total</u>
<u>Northeast Coal & Dock Corp.</u> (Sulphur Receipts) Reduced tidal delays	Present	
	(6.2 hrs/trip x \$178/hr. x 6 trips/yr.) -	
	(4.0 hrs/trip x \$178/hr. x 5 trips/yr.) =	\$ 3,000
	Additional Prospective	
	(6.2 hrs/trip x \$178/hr. x 9 trips/yr.) -	
	(4.0 hrs/trip x \$178/hr. x 7 trips/yr.) = \$5,000	
	Equiv. annual savings = \$5,000 x 0.396 =	\$ 2,000
Eliminated tug service	Present	
	\$2,500/trip x 6 trips =	\$15,000
	Additional Prospective	
	\$2,500/trip x 9 trips = \$22,000	
	Equiv. annual savings = \$22,000 x 0.396 =	\$ 9,000
Eliminated time required for extra port stop	Present	
	\$2,700/trip x 6 trips =	\$16,000
	Additional Prospective	
	\$2,700/trip x 9 trips = \$24,000	
	Equiv. annual savings = \$24,000 x 0.396 =	\$ 9,000
<u>Total</u>		<u>\$54,000</u>

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TABLE VI- ESTIMATE OF BENEFITS

<u>30-Foot Channel</u>		<u>50-year life (growth factor 0.396)</u>
<u>Source & Type of Benefit</u>	<u>Derivation</u>	<u>Total</u>
<u>Northeast Coal & Dock Corp.</u> (Sulphur Receipts) Reduced tidal delays	Present	
	(6.2 hrs/trip x \$178/hr. x 6 trips/yr.) -	
	(1.4 hrs/trip x \$178/hr. x 5 trips/yr.) =	\$ 5,000
	Additional Prospective	
	(6.2 hrs/trip x \$178/hr. x 9 trips/yr.) -	
	(-1.4 hrs/trip x \$178/hr. x 7 trips/yr.) = \$8,000	
	Equiv. annual savings = \$8,000 x 0.396 =	\$ 3,000
B-10 Eliminated tug service	Present	
	\$2,500/trip x 6 trips =	\$15,000
	Additional Prospective	
	\$2,500 x 9 trips = \$22,000	
	Equiv. annual savings = \$22,000 x 0.396 =	\$ 9,000
Eliminated time required for extra port stop	Present	
	\$2,700/trip x 6 trips =	\$16,000
	Additional Prospective	
	\$2,700/trip x 9 trips = \$24,000	
	Equiv. annual savings = \$24,000 x 0.396 =	\$ 9,000
Total		<u>\$57,000</u>

TABLE VII - ESTIMATE OF BENEFITS

<u>35-Foot Channel</u>		<u>50-year life (growth factor 0.396)</u>
<u>Source & Type of Benefit</u>	<u>Derivation</u>	<u>Total</u>
<u>Northeast Coal & Dock Corp.</u> <u>(Sulphur Receipts)</u> Eliminated tidal delays	Present	
	(6.2 hrs/trip x \$178/hr. x 6 trips/yr.) - 0 =	\$ 7,000
	Additional Prospective	
	(6.2 hrs/trip x \$178/hr. x 9 trips/yr.) - 0 = \$10,000	
	Equiv. annual savings = \$10,000 x 0.396 =	\$ 4,000
Eliminated tug service	Present	
	\$2,500/trip x 6 trips =	\$15,000
	Additional Prospective	
	\$2,500/trip x 9 trips = \$22,000	
	Equiv. annual savings = \$22,000 x 0.396 =	\$ 9,000
Eliminated time required for extra port stop	Present	
	\$2,700/trip x 6 trips =	\$16,000
	Additional Prospective	
	\$2,700/trip x 9 trips = \$24,000	
	Equiv. annual savings = \$24,000 x 0.396 =	\$ 9,000
<u>Total</u>		<u>\$60,000</u>

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TABLE VIII-ESTIMATE OF BENEFITS

25-Foot Channel

50-year life (growth factor 0.396)

Source & Type of Benefit	Derivation	Total
Northeast Coal & Dock Corp.		
Coal Receipts -	Present	
Eliminated or reduced tidal delays	(1.4 hrs/trip x \$110/hr. x 3 trips/yr.) - (2.6 hrs/trip x \$132/hr. x 2 trips/yr.) =	0*
	Additional Prospective	
	(1.4 hrs/trip x \$110/hr. x 3 trips/yr.) - (2.6 hrs/trip x \$132/hr. x 2 trips/yr.) =	0*
Reduced delivery costs -	Present	
	\$1.07/ton savings x 15,000 tons/yr. =	\$16,000
	Additional Prospective	
	\$1.07/ton savings x 15,000 tons/yr. = \$16,000	
	Equiv. annual savings = \$16,000 x 0.396 =	<u>6,000</u>
	Total	\$22,000

*Less than \$500. Therefore considered negligible in relation to other benefits.

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TABLE IX - ESTIMATE OF BENEFITS

<u>30-Foot Channel</u>		<u>50-year life (growth factor 0.396)</u>
<u>Source & Type of Benefit</u>	<u>Derivation</u>	<u>Total</u>
Northeast Coal & Dock Corp.		
Coal Receipts -	Present	
Eliminated or reduced	(1.4 hrs/trip x \$110/hr. x 3 trips/yr.)-	
tidal delays	(0.8 hrs/trip x \$132/hr. x 2 trips/yr.)=	0*
	Additional Prospective	
	(1.4 hrs/trip x \$110/hr. x 3 trips/yr.)-	
	(0.8 hrs/trip x \$132/hr. x 2 trips/yr.)= 0	0*
B-13 Reduced delivery costs -	Present	
	\$1.07/ton savings x 15,000 tons/yr. =	\$16,000
	Additional Prospective	
	\$1.07/ton savings x 15,000 tons/yr. - \$16,000	
	Equiv. annual savings - \$16,000 x 0.396 -	<u>\$ 6,000</u>
	Total	\$22,000

*Less than \$500. Therefore considered negligible compared to other benefits.

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TABLE X. ESTIMATE OF BENEFITS

35-Foot Channel

50-year life (growth factor 0.396)

Source & Type of Benefit	Derivation	Total
Northeast Coal & Dock Corp.		
Coal Receipts -	Present	
Eliminated or reduced tidal delays	(1.4 hrs/trip x \$110/hr. x 3 trips/yr.)- 0	0*
	Additional Prospective	
	(1.4 hrs/trip x \$132/hr. x 3 trips/yr.)- 0	0*
Reduced delivery costs -	Present	
	\$1.07/ton savings x 15,000 tons/yr. -	\$16,000
	Additional Prospective	
	\$1.07/ton savings x 15,000 tons/yr. - \$16,000	
	Equiv. annual savings - \$16,000 x 0.396 -	<u>6,000</u>
	Total	\$22,000

* Less than \$500. Therefore, considered negligible compared to other benefits.

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TYPICAL DERIVATION OF DELIVERY COSTS - COAL

(U. S. Flag Vessels)

Vessel Class	Barge (self-propelled)	11,000 dwt collier
Average distance (Norfolk, Va.)	550 mi.	550 mi.
Cruising speed	11 knots	11 knots
Hourly operating costs		
(at sea)	\$110	\$132
(in port)	\$94	\$119
Cost/day (at sea)	\$2,640	\$3,168
Rd. trip @ sea	4.17 days	4.17 days
Cost/rd. trip @ sea	\$11,000	\$13,210
Add 1 day in port	<u>\$2,256</u>	<u>\$2,856</u>
Total cost/trip	\$13,256	\$16,066
D.W.T. (Short tons)	5,700	12,320
Fuel & Stores (sh. tons)	<u>220</u>	<u>381</u>
Cargo (short tons)	5,480	11,939
Trans. cost/ton	\$2.42	\$1.35

Savings = \$2.42 - \$1.35 = \$1.07/ton